Prepared Statement of
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on
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Accounting for the Fiscal Impacts of Controlling Carbon Emissions"
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Mr. Chairman and Members of the Committee:

Thank you for your invitation to participate in today's hearing. I am Anne Smith, and I am a Vice President of CRA International. Starting with my Ph.D. thesis in economics at Stanford University, I have spent the past twenty-five years assessing the most cost-effective ways to design policies for managing environmental risks, including cap-and-trade systems. For the past fifteen years I have focused my attention on the design of policies to address climate change risks, and have prepared many analyses of the economic impact of climate polices. I thank you for the opportunity to share my findings and climate policy design insights with you. My written and oral testimonies reflect my own research and opinions, and do not represent any positions of my company, CRA International.

The topic of today's hearing is the fiscal impacts of controlling carbon emissions. Much of the discussion these impacts revolves around options for how the government can shift the economic burden of a cap-and-trade system on greenhouse gases through alternative formulas for allocating the capped allowances. When a market-based approach to greenhouse gas emissions control is implemented, a very large amount of wealth in the form of the allowances will be created, even while the policy also forces net resource costs on society. No one should be surprised by the intensity of interest focused on how that wealth might be distributed because any single interest group could be made far wealthier under a carbon cap-and-trade program than not -- *if* it can get the "right" kind of allocation assigned to it. Without denying the great importance of the allocations decisions, I would like to make a number of observations about the resource costs and economic impacts of such policies that policymaker's should not lose sight of when contemplating greenhouse gas emissions legislation.

MINIMIZING THE POLICY'S COST VERSUS SHARING ITS COST

The total value of allowance allocations will always be less than the total cost of a carbon cap: the policy will always have a net cost.

The total resource cost of an emissions limit is the sum of the expenditures that emitters will make in order to physically reduce their emissions from what they would otherwise have been. Under a market-based system, a limit is placed on emissions, and regulated emitters are required to pay for every ton that they emit. If the policy is a cap-and-trade system without any free allocations, emitters do this by buying as many allowances as they emit in a year, and rendering those allowances to the government. Because there are not as many allowances as there would be emissions (at least in the aggregate), emitters also are forced to reduce their emissions. Thus, there are two expenditures that emitters incur: (1) they spend money to reduce emissions down to the level of the cap and (2) they pay for allowances to cover all of their emissions that remain after the controls have been applied.

In aggregate over all emitters, the second component of total expenditures by emitters is simply the value of the allowance pool that is created by the government when it sets up a cap-and-trade system. Therefore, the entire wealth that government will have to allocate is only equal to the second component of the emitters' costs. The government can give that entire value back to the companies by making a free allocation of 100% of the allowances to emitters, but that leaves companies still incurring the first cost component – the real resource cost associated with actually reducing emissions, which is the real net cost to society.

The wealth associated with the allowances can be very large compared to the real resource costs of the cap. For example, if emissions without a cap are 100 tons and a 10% reduction is required by establishing a cap at 90 tons, the cost of controls (and hence the market value of the 90 tons of allowances) might be $20/ton of CO_2. In that case, the real resource cost of reducing 10 tons of emissions would be less than $200 whereas the market value of the pool of 90 allowances would be $1800. However, even if the government gave all the allowances to the emitters, it would only reduce emitters' expenditures from $2000 (i.e. the sum of $200 for emissions controls and $1800 to buy allowances for their remaining emissions) down to the net societal resource cost $200.[1]

The net resource cost is therefore an inescapable fact of an emissions limit via a cap-and-trade program that cannot be eliminated through any allocation formula that may be devised. All that an allocation scheme can do is alter the companies and individual consumers that end up bearing the burden of that resource cost. An excessive amount of focus on who will gain the value in the allocations can cause policymakers to lose sight of the fact that they are creating a new cost to society that should be evaluated in the context of overall societal budget priorities.

[1] Emitting companies may be able to pass some of these two cost components on to their customers, and so directly-regulated companies could be given more compensation than the cost that their shareholders bear if all of the allowances were allocated to them alone. However, this only means that a part of the net cost has been spread to other, non-regulated parties, including consumers. They, in turn, would require their share of the allowance allocation to be compensated for the part of the cost that was passed to them. There is not enough value in the allowances to cover all costs to regulated companies if they cannot pass those costs on, and neither can that value cover all the incurred costs even if they are passed through to customers and spread throughout the entire economy.

The net cost of a carbon cap of the stringencies now being discussed in the Congress would be very substantial.

A large number of proposals have circulated in recent months that entail hard caps on US greenhouse gas emissions reaching reductions of about 75%to 90% from projected "business as usual" emissions by 2050. These current hard cap proposals vary in their specific timing and stringency, but all of them would impose significant costs on the US economy even in the near term, if implemented. I have performed economic impact analyses of many different levels and types of emissions limits using CRA International's general equilibrium model of the US economy called "MRN-NEEM." My analyses indicate that the current set of proposals in the Congress for hard caps on greenhouse gas emissions would impose real resource costs to the US economy of the following general magnitude:

- Net losses in the average household's real spending of $1000 to over $1500 per year by 2020.
- Net reductions in jobs by 2020 of 2 million to 4 million.
- Reductions in US gross domestic product (GDP) of $300 billion to $500 billion (i.e., a reduction of 1.5% to 2.5%) from a case with no carbon limits, by 2020.

Needless to say, a drop in GDP implies a reduction in government revenues too – also roughly on the order of 1.5% to 2.5% by 2020. The costs of these proposals are projected to increase continuously up to 2020, and are only somewhat lower in their very first year of implementation. Further, these costs are projected to continuously increase in the decades beyond 2020, because the reductions they require by 2020 are small compared to those that would be mandated by 2050 in these Bills.

These economic impacts are substantial enough that they warrant a very serious discussion about priorities for the spending of our society's resources. There is no question that achieving significant reductions in greenhouse gas emissions will be very costly, and it is therefore important to strive to minimize those costs. That cannot be done by focusing solely on how to allocate allowances. The design of the program itself is what matters, which requires taking care to ensure the following attributes in a cap-and-trade system:

- A cap that comprehensively covers all types of emissions sources.
- A policy that protects against leakage of emissions to economically competing nations.
- A supportive set of policies that provide effective incentives for research and development on breakthroughs in technologies that produce low-carbon energy.
- A cap stringency that is timed to match the availability of new, low-carbon technologies.
- A policy that offers businesses price certainty for planning major new investments in new technologies.
- Provisions in the policy to limit the costs that it will impose on the economy overall if emissions reductions turn out to be more expensive to achieve than currently anticipated.

- A policy that will deliver even larger emissions reductions if they turn out to be less expensive to achieve than currently anticipated.

None of these attributes are easy to design into a greenhouse gas policy, and none of the hard cap proposals that are currently being discussed in the Congress have sufficiently addressed these needs. Their projected costs (described above) are thus probably unnecessarily high for achieving their stated emissions goals. I will discuss several of these points in more detail below, after a few more comments about allocations.

There are very many claimants to the value associated with the allowance allocations. The costs of greenhouse gas reductions will directly increase the costs of companies that are emitters targeted by a regulation. These companies are thus the traditional and natural claimants on the allocations. However, in the case of greenhouse emissions limits, many of those emitters' costs will be passed on to consumers. This will occur through multiple routes. Energy prices will increase. The costs of most goods and services will increase because they can only be produced by using energy. Some companies will be forced out of business, with attending consumer costs of making job transitions. Energy cost impacts will be regressive, and affect the poor disproportionately. All of these impacts create additional groups in society that also can make a valid claim for a share of the wealth associated with the allowance pool. Finally, in addition to the claims from industry, businesses, workers, and representatives of the socio-economically disadvantaged, government must also contend with its *own* needs. Government needs to support a massive increase in energy research and development. Government also needs to grapple with likely declines in its traditional tax revenues due to the costs, reduced profits and reduced household incomes that the policy imposes on its tax base.

Clearly, policymakers face an unusually complex situation where almost every group in the economy has a reasonable claim for some share of the allowance value. This becomes an outright dilemma when one realizes that there will never be enough allowance value to cover all of the claims. When the net resource costs of the policy are so large, policymakers should focus should be on creating the most cost-effective policy possible; an emphasis on allocations rules does not further this goal.

Alternative allocation formulas being proposed would not reduce the overall societal cost of a cap-and-trade policy.
As I have described above, the value associated with the allowance pool that would be created under a cap-and-trade scheme is a "transferable" amount of wealth. By allocating that wealth in different ways, the cost burden of the policy can be adjusted across the many players in the economy. That is, the allocation formula just splits the same pie in different ways. If one group is handed a pie slice that is larger than its slice of resource costs, that group will be better off. But because the total pie of transferable wealth is smaller than the total pie of expenditures that emitters must incur, a larger allocation for one group inevitably means that another group will be less well off. Almost all of the alternative allocation formulas being discussed would merely alter how the pie is sliced, and not how large the pie is.

There are only two alternative uses of the allowance value that would actually reduce the net economic burden of a greenhouse gas policy, and neither one receives very much attention in current bills in the Congress:

1. It is often stated that giving away free allowances reduces the opportunity for the government to enhance economic activity by lowering the economic distortions of existing taxes. If the allowances could instead be auctioned and the new revenues to the US government used to reduce these existing "tax distortions," then there would be a generalized benefit to the economy that could partially offset the newly imposed economic cost of the emissions reductions. However, not a single one of the many policy proposals that have been introduced in Congress has proposed to use the auction revenues in the manner necessary to gain this offsetting economic benefit. It requires specifically that the auction revenues be used to reduce the *marginal* tax rate on either the personal income tax or on corporate tax rates. Several analyses have found that this could reduce the net impact to the economy of a cap by as much as 50%.[2] However, it is highly unpopular politically because of its expected regressive nature.[3] (In fact, reduction of marginal payroll tax rates would have much less beneficial impact than reduction of marginal personal income tax rates, and even less than if the marginal corporate income tax rates are reduced, each of which would be increasingly regressive.) While economists agree that reduction of marginal income tax rates would be an excellent way to reduce the net economic impact of a policy, policymakers seem incapable of implementing the right form of tax rate reductions to claim policy cost reduction as a justification for auctioning a larger share of permits. Rebate checks to households, reductions in average tax rates, and other forms of tax reductions called "lump sum" do not accomplish any such policy cost reduction.

2. It is widely accepted that another way to reduce the cost of a greenhouse gas cap would be to reduce the costs of, and to speed the time of commercial availability, of new and advanced low-carbon technologies. This might be accomplished through government policies that offer greater and more cost-effective incentives for targeted and successful research and development in energy technologies. Most of the recent carbon policy proposals attempt to direct some of the allowance value towards technology development, and this is a positive development. However, most of these proposals' provisions are limited to subsidies and demonstration project funding. They still give insufficient attention to how to actually improve the incentives for both public and private researchers to effectively target their efforts towards new, breakthrough technologies. Far more effort needs to go into designing these research and development initiatives before one can argue that allocating a larger share of allowances or auction revenues to fund technology programs will have much effect in reducing the cost of the associated cap.

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[2] For a review of the literature and specific analytical examples, see A. E. Smith, M. T. Ross and W. D. Montgomery, *Implications of Trading Implementation Design for Equity-Efficiency Trade-offs in Carbon Permit Allocations*, Charles River Associates Working Paper, December 2002.
[3] Congressional Budget Office, *Trade-offs in Allocating Allowances for CO_2 Emissions*, Economic and Budget Issue Brief, April 25, 2007, Figure 1.

CLARIFICATION OF SOME ISSUES REGARDING ALLOCATIONS TO EMITTERS

Assertions that emitting businesses require "less than 15%" of the allowances to compensate them for their losses due to a carbon cap costs are misleading, and incorrect in most cases.

A common assertion within greenhouse policy circles is that only a small fraction of the total allowances need be given to emitters to offset their profit losses. The Congressional Budget Office (CBO) has characterized this "small fraction" as less than 15%.[4] I am one of the researchers whose analyses are cited in support of CBO's statement. I would like to identify several problems with that are associated with this type of oversimplifying summary statement.[5]

- Phase out of allocations over time. The small percentages of allowances that modeling studies find would offset sectoral average profitability losses are calculated *assuming* that the free allocation percentage will remain constant permanently (i.e., infinitely) into the future. In real application (and in all present policy proposals), the allocations are *not* permanent, but are phased out; yet the policy's impacts only continue to increase over time. If an allocation is to be phased out over time, the percentage share that achieves the same degree of compensation is higher. For example, an 8% perpetual allocation would need to become a 54% allocation per year if it were to end after ten years.[6] It would need to be in the range of 50% or more in the first year, if it were to be phased out gradually over 20 or more years.

- Compensation estimated only for average sectoral impacts. The estimates of a percentage of allocation that would compensate "businesses" is actually based on a model that does not consider individual businesses, but only entire aggregate sectors, such as the "energy-intensive industries" sector or "the electricity generating" sector. There will, in fact, be both winners and losers in any large aggregated sector, and these models cannot distinguish between them. Instead, the share of allocation estimated to compensate the entire sector *on average* assumes the winning companies' gains within a sector can be netted against the losses of the losing companies. This is like saying that profitability increases to wind farmers and nuclear generators due to a cap will be taken from them and given to coal generators. *Then*, any remaining net losses to coal generators would be compensated by free allocations to that sector. If one of the modeled sectors had an equal balance of winners and losers, the model would estimate a zero need for any allocations to that sector – clearly that would be insufficient to compensate companies facing profitability losses within that sector. In one case where the

[4] Congressional Budget Office, *op. cit.*, p. 5.
[5] The points are further explained in my paper (Smith, Ross and Montgomery, *op cit.*). The CBO does acknowledge some of the following, but the caveats noted by CBO are not usually noticed, although they are extremely important to how this research is applied to actual policy design.
[6] Smith, Ross and Montgomery, *op cit.*, p. 54.

analysts were able estimate the allocations needed to compensate each individual business rather than the sectoral average, the analysis found that that actual compensation of every individual business would require a 33% allocation to that sector, even though the analysis indicated a 0% allocation need when estimated on the typical sectoral average basis.[7]

- Compensation estimates largely ignore how trade exposure reduces abilities to pass costs through to customers. One of the reasons that some businesses may be able to be compensated for their profit reductions under a carbon policy is that they can actually pass a large share of their cost on to the consumer. That is, impacts to their profits are not as large as their increased compliance expenditures. The economy-wide models that have been used to assess how many allocations are needed to compensate sectors are not detailed enough to address the degree to which different sectors are able to pass costs through in their product prices, and they tend to overstate the pass-though. In particular, if parts of some sectors are highly exposed to competition from international competitors, they have exceptionally little ability to raise prices, because they will lose market share to foreign producers. However, when aggregated with a variety of other types of businesses in a “sectoral model,” their actual vulnerability to cost increases is averaged away. The model will assume they can achieve an average degree of price pass-through, and thus understate the profitability impacts of the very highly trade-exposed within each sector. Those types of companies would require larger allocations than the modeling exercises have estimated.

- Comprehensiveness of cap’s coverage. The modeling exercises have modeled idealized caps that would be applied uniformly to all emissions in the US. However, if a real-world cap were to only apply to about 50% of the emissions, while non-market policies and measures would be applied to the remaining sources, then the economic impacts of the policy would be the same or higher, but there would only be half as many allowances (and half as much allowance value) available to allocate. The amount of value needed to offset profitability impacts would be the same, but in this case, achieving that amount of compensation would require allocation of twice as large of a percentage of the allowance pool (because it is half as large). The bottom line is that as the comprehensiveness of the cap is lowered, the percentage of the allowances needed to achieve the same level of compensation rises.

The above set of bullets points identify many limitations in the ability of models to address the question of fair compensation. The ideal solution would be to develop more disaggregated models to refine the estimates. Unfortunately, there are limits to what any models can do, due to lack of the necessary disaggregated data. In the end, there are no available analytical methods for determining allocations of allowances to individual companies throughout all sectors of the economy that would equitably mitigate the financial impacts of the policy.

[7] Congressional Budget Office, *op. cit.*, p. 5, footnote 15.

The available analyses do suggest that not all companies would require a 100% allocation in order to be compensated. However, any rule of thumb based on the quantitative results of these analyses (such as "less than 15%") probably understates the true aggregate need when several of the real-world features of climate policies are taken into account. Such simplistic rules also clearly are not correct at the level of individual businesses, some of which will benefit without any allocation, and others of which may not be compensated even with a 100% allocation.

Domestic companies whose products compete in international markets are likely to be driven out of business no matter what allocation they receive.
A generous allocation could increase the shareholder value of a company that is unable to increase its prices due to competition in international markets (i.e., a "trade exposed" industry). However, it will do this in a perverse way that policymakers need to be aware of. As the price of allowances rises, a company that cannot raise its product prices will experience falling margins. If that company is also granted free allocations, it can use them to offset some of the costs, and thus maintain profitability. However, this will only be true for a range of lower allowance prices. For every type of company that cannot pass costs through, there will be an allowance price level at which the company would be able to make more money by selling its allowance allocation than by using those allocations to continue to produce its usual product. When allowance prices reach that level, the company will cease production, and become a seller of allowances instead. The shareholders may be satisfied with their financial situation, and use the proceeds of their allowance sales to invest in some different business venture that can be profitable in the carbon-constrained world. However, from the vantage point of the US economy, there will be premature retirement of the existing productive assets in our trade-exposed sector, and reductions in the economic activities associated with those sectors.

This is hardly fits the image that some may have of the notion of achieving compensating allocations for the businesses. Yes, the losses in profitability are offset for the affected shareholders, but this goes hand in hand with plant closures and loss of key economic sectors. Given that the cause of the closures is international competition, these lost US manufacturing activities would be replaced by foreign manufacturing: global emissions will not fall but the US economy will still pay the price.

This perverse outcome of climate policy is called "leakage" because the policy is rendered ineffective environmentally when it causes emissions to "leak" across national borders. Emissions from any part of the globe have comparable impacts on climate risks, as they all first accumulate together in the global atmosphere to have their combined and joint effect on the global greenhouse effect. On the one hand, this offers important flexibility to reduce emissions anywhere in the globe that has cost-effective opportunities to do so, and not to confine domestic efforts to actions within US borders. On the other hand, it also means that any GHG cap we impose domestically, and its attending domestic reductions, may be undermined by offsetting emissions increases in nations that do not have comparable caps on their own economies. Large sums of money could be spent with no actual global environmental benefit. US economic output and jobs leak to other countries as well.

Leakage has often been talked about in very general terms. Estimates of leakage due to a US domestic policy are suggested in the range of about 10-15%, meaning that for every 10 tons that is reduced in the US, 1 ton is just emitted elsewhere in the world. This may sound like a relatively small price to pay in order to get a net 9 tons of reduction from US action. The difficulty with this view, however, is that leakage is not a phenomenon that applies to every ton of emissions reduction. Instead, there may be almost no leakage associated with controls on emissions that are not trade-exposed (e.g., personal and commercial transportation, electricity generation, and services), but nearly 100% leakage associated with controls on emissions in sectors that *are* trade-exposed (e.g., many of the energy-intensive manufacturing processes such as cement, iron and steel, chemicals, transportation equipment manufacturing, textiles, etc.) Concentrated economic impacts on specific sectors that offer no benefit in terms of global emissions reduction make no sense as a matter of policy design. The possibility that the shareholders could be made whole is not a relevant argument to allow this to happen.

The potential severity of the impacts to trade-exposed industries appears not yet fully appreciated by policy analysts or policymakers. Most of the attention on estimating climate policy impacts has been focused on transportation and electricity generation, which are among the least concerned with potential leakage. The potential plight of the trade-exposed industries has been mostly thought to be something that could be dealt with through compensating allocations. While that might solve the concerns of some of the shareholders of those businesses, policymakers should closely examine whether they are prepared to face the economic impacts of reduced exports, increased imports, and losses of domestic output of many important elements of the US manufacturing base.

SOME OPTIONS FOR REDUCING NET ECONOMIC IMPACTS

I noted in the first section that there are a few attributes of a greenhouse gas policy that would be important to keeping the policy's economic impacts in an acceptable and politically sustainable range. I believe that these require at least as much attention in designing a policy as the question of how to allocate allowances. This section provides some discussion of several of those attributes.

Policymakers should focus on how to limit US emissions without creating leakage. As I noted in the last section of these comments, leakage is a serious concern for some portions of the economy, and not one that can be addressed satisfactorily with some free allocations to the trade-exposed sectors. There are two ways to mitigate leakage without exempting trade-exposed sectors from an emissions cap:

1. The first is to impose domestic emissions limits only as part of a global agreement among all nations that compete with our products, or which might start to compete once a policy offers them a greater cost advantage than they have now. Clearly, the present policy proposals in the Congress would not accomplish this.

2. The second is to find ways to remove the competitive advantages of competitors at our borders, through "border tax adjustments." Border tax adjustments are

allowed only under very special circumstances under the rules of the World Trade Organization.

The legality of obtaining effective border tax adjustments in the case of a cap-and-trade system is quite questionable at present.[8] While a proposal to do so has been circulated by American Electric Power and the International Brotherhood of Electrical Workers (the "AEP-IBEW" proposal), it appears to have dubious chances of success in limiting leakage due to a cap-and-trade proposal. The AEP-IBEW proposal contains quite a complex set of provisions, each aimed at addressing one of several hurdles that would be faced in order to achieve the ultimate goal of equalizing costs of imports at the US border in a WTO-compliant manner. Each element of the proposal would be open to legal challenge, leaving multiple potential ways that the approach could fail to provide the intended protection from leakage. Most critical in my mind, however, is that these many steps require time to accomplish. As embodied in the bill of Senators Bingaman and Specter, the imposition of leakage protection from the AEP-IBEW scheme might not be possible until 2020. Given that the cap in that policy would start in 2012, this would imply up to eight years during which US trade-exposed manufacturers would be facing competitive pressures, eroded ability to profitably continue in business, and experiencing leakage. Delays of this sort in obtaining that coverage are not acceptable for the businesses that face rapidly responding markets.

The AEP-IBEW proposal for obtaining WTO-compliant leakage protection was crafted to work with a cap-and-trade form of proposal. Interestingly, the prospects of successfully and immediately implementing border tax adjustments are considered to be much greater in the case of a greenhouse gas tax than in the case of cap-and-trade.[9] Those having a hand in creating a climate policy for the US should become much more familiar with the intricacies of WTO rules, and the likelihood of successfully creating immediate and durable protection from leakage under different types of greenhouse gas policy designs. This needs to be sorted out *before* and not after a greenhouse gas policy is enacted.

In the absence of a clear mechanism for preventing leakage with a cap-and-trade system, the only alternative for keeping economic impacts within acceptable bounds is to place a ceiling on the cost of allowances.

The higher the price of permits under the domestic cap, the more serious "leakage" is likely to be if there are no border tax adjustments in place. Thus, potential for leakage provides an important reason for directly ensuring that the price of permits that may occur under a domestic GHG cap-and-trade program will remain relatively low. The only way to design a domestic cap-and-trade program to address this international competitiveness risk is simply to keep the carbon price low enough that such losses remain within acceptable bounds. This, naturally, limits the amount of domestic emissions reductions that will be achieved as well. Until international competitiveness issues are resolved (either through coordinated action or a system of border tax adjustments) ambitions to make significant

[8] J. Pauwelyn, *U.S. Federal Climate Policy and Competitiveness Concerns: The Limits and Options of International Trade Law*, Nicholas Institute for Environmental Policy Solutions Working Paper NI WP 07-02, April 2007.
[9] *Ibid.*

reductions through any domestic cap-and-trade program will be thwarted, or else highly disruptive to key parts of our economy. This also implies that any domestic cap-and-trade program that *is* implemented in advance of internationally coordinated efforts should be designed with clearly defined permit price caps.

An allowance price ceiling has important additional merits for businesses and government.

Prices in all previous and existing cap-and-trade programs have exhibited substantial volatility, and this can be expected of GHGs as well.[10] Price volatility, however, is likely to have much greater generalized economic impacts with a CO_2 cap than for caps on SO_2 and NO_x. CO_2 is a chemical that is an essential product during the extraction of energy from any fossil fuel. As long as fossil fuels are a key element of our energy system (which they are now, and will remain for many years even under very stringent caps), any change in the price placed on GHG emissions will alter the cost of doing business throughout the economy. This is because all parts of the economy require use of energy to one degree or another.

In contrast, under the Title IV SO_2 cap, a fluctuating SO_2 permit price would only affect emissions from coal-fired electricity generation. In deregulated electricity markets, coal-fired electricity does not always affect the wholesale price of electricity, and even significant fluctuations in SO_2 permit prices might have almost no effect on electricity prices. Even in regulated electricity markets, the impact of the SO_2 price on the cost of all electricity generation would be diluted by the unaffected costs of all other sources of generation before it reached customers. Also in contrast to an economy-wide GHG cap, no other sources of energy in the economy are affected at all by SO_2 price changes. Finally, under the Title IV SO_2 cap, price variations during the past year that range from $400/ton to $1500/ton (the range observed in the past year under Title IV) have a modest effect on the majority of coal-fired units that are already either scrubbed or burning low-sulfur coal. Such units might see the cost adder due to its SO_2 emissions vary between 7% and 26% of its base operating cost,[11] and (as noted) the impact on consumer's cost of electricity would be much smaller, if anything.

Variation of CO_2 prices such as that observed in the EU ETS market over the past two years (approximately $2/ton to $35/ton) would cause *all* coal-fired units to see additional costs varying between about 10% and 175% of their base operating costs. Further, even gas-fired units would experience absolute cost increases equal to about half those of the

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[10] Some have argued that banking reduces price volatility. While it may reduce it, it certainly does not eliminate it. For example, the Title IV SO_2 market has experienced high volatility over the past two years, even though it has a large bank already in place. During 2005, SO_2 permit prices rose from about $600/ton to above $1600/ton, then plummeted to below $400/ton by the beginning of 2007. Additionally, banking offers little price stability at all during the start up of a new cap, simply because no bank yet exists, and this initial-period volatility can be very large if the first-period cap requires a substantial amount of reduction and/or has a relatively brief regulatory lead time. The experience of the first year in the NO_x cap of the Ozone Transport Region of the northeastern U.S. is a classic example.

[11] By "base" operating cost, I mean the cost of generating a unit of electricity before accounting for the emissions price. The majority of this cost is the cost of the fuel.

coal-fired units.[12] Since gas-fired units do frequently set the wholesale market price of electricity, consumer electricity prices would also vary markedly with the price of GHG permits. Retrofits would not be available to attenuate these costs (at least, not until even higher permit price levels would be achieved and *sustained* at those levels.) At the same time, all other key energy demands in the economy (e.g., for transportation, industrial process heat, building heating and air conditioning, etc.) would also experience similar fluctuations with varying GHG permit prices. Clearly, the effect on the economy could be disruptive.

These are not just theoretical calculations. The EU's statistics bureau, Eurostat, reports that electricity prices rose significantly throughout the EU in 2005. Household rates rose by 5% *on average* over all 25 EU countries, and industrial rates rose by 16% on average.[13] The high prices of GHG permits under the EU ETS during that period is widely viewed as having contributed to this price increase, and indeed, wholesale electricity prices have fluctuated in step with the wide swings in ETS permit prices. It is not clear yet how or whether the wide variations in permit prices may begin to contribute to the variation in economic activity. However, it should also be noted that the EU ETS does not cover all sources of GHGs, or even a majority of sources of CO_2 emissions in the EU. (This may dampen the impacts of CO_2 permit price volatility on the EU economy, but is also a widely observed flaw in that cap-and-trade system's potential to produce sufficient cuts in GHG emissions necessary for the EU to meet its GHG targets.)

To sum up, price uncertainty and price volatility will impose impacts in the case of GHG emissions limits that are completely different in scale and scope from those under previous emissions trading programs. Their potential to increase variability in overall economic activity thus should be viewed as a core concern in designing a GHG cap-and-trade program. At the same time, the nature of climate change risks associated with GHG emissions is such that it is possible to design price-stability into a GHG cap-and-trade program without undermining its environmental effectiveness. In the case of a stock pollutant such as greenhouse gases, there is no need to absorb high costs in return for great specificity in achieving each year's emissions cap.[14] Economists widely agree that the cost to businesses of managing the price uncertainty of a hard cap is not worth the greater certainty on what greenhouse gas emissions will be from year to year.

Businesses clearly prefer having reliable allowance price expectations, but even governments would probably prefer some stability in the year to year revenue streams from an auction. For example, would large variability and uncertainty in allowance auction revenues be of any use if those revenues are intended to fund important technology-related projects that have long-term funding needs? Even if the revenues would simply be rebated

[12] However, the percentage increase in the base operating cost would be much smaller (i.e., about 30% compared to 175%) because natural gas is so much more expensive than coal.
[13] Eurostat, "News Release – July 14, 2006" (Revised version 93/2006), available at http:/ec.europa.eu/eurostat
[14] Richard G. Newell and William A. Pizer 2003, "Regulating Stock Externalities Under Uncertainty," *Journal of Environmental Economics and Management,* Vol. 45, pp. 416-432.

to citizens, would either the government or the citizens find any value in such uncertainty in the size of the rebate checks?

There are various ways to provide much greater price certainty under a cap-and-trade program, although none have been used in any trading programs to date. One of the simplest concepts that has gained substantial attention for GHGs has been called a "safety valve." Unfortunately, this term has begun to be used loosely (e.g., under the rules of the Regional Greenhouse Gas Initiative, and in California's AB32 program) for a variety of mechanisms that do not actually provide the price certainty originally intended. To be quite specific, the cap-and-trade program mechanism that provides the requisite price cap is one where the government offers to issue any number of additional permits to regulated companies at a pre-specified and fixed price per permit. This price is set low enough that it is not considered punitive, but rather as an assurance by the government that it would not consider control costs above that level to be desirable as a normal course of events.[15] This is the mechanism that has been incorporated into the bill of Senators Bingaman and Specter.

Because regulated entities know that they need not ever pay more for a permit than the established safety valve price, it functions as a price ceiling. No company would ever pay more to purchase a regular permit in the emissions market if it knows that it can always obtain sufficient permits at that price from the government, if necessary. Permit prices may fluctuate at levels below the safety valve price, but by judicious selection of an appropriate safety valve price, policy makers can ensure that these variations would not rise to a level that might be viewed as potentially harmful to the economy at large. If the safety valve price is hit on an occasional basis under a cap, then the goal of achieving long-term reductions in emissions is not harmed, given that the primary environmental risk of GHG emissions is a long-term, cumulative one. If the safety valve price is hit on a perpetual basis, this suggests an important need for policy makers to consider how we should address the evidence that meeting targets that are more difficult than hoped; however, this policy deliberation will be possible without the urgent need to throw "band-aid" solutions onto the cap-and-trade program, and with concrete evidence of the degree of economic pain that is associated with the initially-established maximum permit price. A higher price might then be deemed acceptable, but if not, the safety valve will have helped us avoid the greater pain of learning that fact through a hard cap approach.

[15] Outside of the U.S., further confusion about the notion of a "safety valve" has been created by application of this term to the traditional notion of a penalty for noncompliance. The EU ETS has a penalty for noncompliance that is €40/ton CO_2 in Phase I and will be €100/ton in Phase II, starting in 2008. This is often described as a price cap, but its very high level relative to the price at which the cap is expected to be met makes it extremely ineffective. Further, its role as a penalty rather than as an additional compliance mechanism clearly would undermine the willingness of companies to resort to its use for planning purposes. The same confusion of penalty and safety valve appeared in the proposal for an Australian emissions trading scheme released in 2007 by Australia's National Emissions Trading Taskforce. The notion of a "safety valve" should be clearly separated from the role of a noncompliance penalty, with the former being set at a price that is considered an acceptable level of policy implementation cost, and the latter being set at a much higher level that is considered "punitive" and not acceptable as an indicator of the cost of meeting the policy goals.

Aversion to the idea of a price ceiling has been widespread among parties that prefer hard caps at any cost over a long-run policy that offers price certainty in exchange for some flexibility in year to year emissions outcomes. Recently, a proposal for a "Carbon Market Efficiency Board" (CMEB) was released that was supposed to offer an alternative to the price ceiling approach.[16] This concept has since been incorporated into the bill of Senators Lieberman and Warner. This CMEB proposal provides no cost certainty at all, and it explicitly states that it does not wish to diminish allowance price volatility: "The cost relieve measures are not intended to relieve brief price spikes that are part of normal, healthy market volatility." [17] The proposal goes on to assert that " 'volatility' in price is expected and even desirable."[18] As I have noted above, volatility creates unnecessary planning and management costs to businesses, and should be eliminated if possible without harming one's objectives for reducing emissions within acceptable cost bounds. This is entirely possible in the case of a market that is entirely the result of regulation, such as an allowance market. The CMEB proposal does not meet the objectives of providing price certainty or policy cost containment.

THINKING OUTSIDE OF THE CAP

Almost everybody considers it as a foregone conclusion that cap-and-trade is the only option for achieving cost-effective reductions in greenhouse gas emissions. However, in efforts to secure a greater share of the allowance values for non-industry interests, and in efforts to raise government funds for supporting research, and even in efforts to raise government revenues to reduce other taxes, there is growing pressure for a large share of the allowances to be auctioned. In the limit, however, an auction works just like a tax – except that the level of the tax is unknown in advance of passing the legislation, and will probably remain highly variable over time even after implementation of the legislation. This price uncertainty is not a helpful element to achieving reductions at lowest possible cost to the economy.

If we find ourselves shifting into a world where auctions predominate, one must ask: why not simply apply a tax? All parties -- public and private – would benefit from the much greater price certainty, reduced administrative and strategic planning effort. Often expressed concerns with manipulation of allowance markets (for both the auction and the secondary markets) would also be eliminated. Further, as CBO has demonstrated in one of its issue briefs, the tax approach can outperform either a hard cap or a cap with a price ceiling in terms of cost-benefit outcomes.[19]

Thus, it may be wise for policymakers to take time to consider more closely alternatives to the cap-and-trade approach for greenhouse gases. Cap-and-trade is not the only form of market-based policy option, and others may be more suitable for the challenge of reducing

[16] "Cost Containment for the Carbon Market: A Proposal," developed in consultation with the Nicholas Institute of Environmental Policy Solutions, Duke University, July 24, 2007. Available: http://www.nicholas.duke.edu/institute/carboncosts/carboncosts.pdf.
[17] *Ibid*., p. 3.
[18] *Ibid*., p. 7.
[19] Congressional Budget Office, *Limiting Carbon Dioxide Emissions: Prices Versus Caps*., Economic and Budget Issue Brief, March 15, 2005.

greenhouse gases to levels that are being proposed without excessive damages to our economy.

With those central points in mind, I want to close by noting that even a highly effective and efficient market-based approach for GHGs will have a serious limitation that should not be forgotten. An adequate national climate policy must consist of more than a system of efficient GHG controls. Actual stabilization of climate change risks will require that GHGs be reduced to nearly zero levels. Although this goal may be possible to achieve at some point in the later part of this century, it can only be done through truly revolutionary technological progress and the resulting changes in the structure of how our energy systems.

Hoffert *et al.* report that “the most effective way to reduce CO_2 emissions with economic growth and equity is to develop revolutionary changes in the technology of energy production, distribution, storage and conversion.”[20] They identify an entire portfolio of technologies requiring intensive R&D, suggesting that the solution will lie in achieving advances in many categories of research. They conclude that developing a sufficient supply of technologies to enable near-zero carbon intensity on a global scale will require basic science and fundamental breakthroughs in multiple disciplines. Therefore, Herculean technological improvements beyond those that are already projected and accounted for in cost models appear to be the only hope for achieving meaningful reduction of climate change risks. By inference, no cap-and-trade system should be placed into law that does not simultaneously incorporate specific provisions that directly support a substantially enhanced focus on energy technology R&D.

Placing a price on carbon emissions, as a cap-and-trade program would do, would affect the pattern of private sector R&D. However, this so-called “induced-innovation effect” would be small. Economic analysis shows that market forces produce a less than socially optimal quantity of R&D. Once a private sector innovator demonstrates the feasibility and profitability of a new technology, competitors are likely to imitate it. Copycats can escape the high fixed costs required to make the original discovery. Therefore, they may gain market share by undercutting the innovator’s prices. In that case, the initial developer may fail to realize much financial gain. Foreseeing this competitive outcome, firms avoid investment in many R&D projects that, at the level of society as a whole, would yield net benefits.[21]

The task of developing new carbon-free energy sources is likely to be especially incompatible with the private sector’s incentives. With no large emissions-free energy sources lying just over the technological horizon, successful innovation in this area will require unusually high risks and long lead times. As Hoffert *et al.* pointed out, developing the needed technologies will entail breakthroughs in basic science, placing much of the

[20]M. I. Hoffert *et al*., “Advanced Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet” *Science*, Vol. 298, Nov.1, 2002, p. 981.
[21] These points are developed in a more rigorous fashion in W. D. Montgomery and Anne E. Smith “Price, Quantity and Technology Strategies for Climate Change Policy,” in M. Schlesinger *et al* (eds.) *Human-Induced Climate Change: An Interdisciplinary Assessment*, Cambridge University Press, 2007.

most essential R&D results beyond the boundaries of patent protection. These are precisely the conditions under which for-profit firms are least likely to rely on R&D as an approach to problem-solving. Thus, greenhouse gas caps on their own would insufficiently increase private sector R&D directed toward technological solutions to abatement.

Market-based policies can very effectively stimulate incremental innovation and deployment into the market place of emerging new technologies. They cannot, however, stimulate the kinds of technological progress necessary to enable meaningful emissions reductions later on. Realistically, then, government must play an important role in creating the correct private sector incentives for climate-related R&D, as well as in providing direct funding to support such activity. This role must be built into any cap-and-trade policy, in order to avoid establishing an emissions policy that cannot fulfill expectations, and to avoid wasteful diversion of key resources for the requisite forms of R&D.

Merely establishing cap and trade cannot meet the crucially important need for enhanced emphasis on basic research rather than additional subsidies for specific technologies that are already far along in the development process. It also does not clearly define government's role or an appropriate division of labor or risk between the public and private sectors in the development of new technologies, whether as commercialization and incremental improvement of existing low-carbon technologies, or R&D for new, breakthrough technologies. Creating an effective R&D program will not be easy, but it ultimately has to happen if climate risks are to be reduced. The difficult decisions are how much to spend now, and how to design programs to stimulate R&D that avoid mistakes of the past.

In conclusion, the current policy debate about how to impose near-term controls through cap-and-trade programs is encouraging policy makers to neglect much more important, more urgently needed actions for reducing climate change risks. The top priority for climate change policy should be a greatly expanded government-funded research and development (R&D) program, along with concerted efforts to reduce barriers to technology transfer to key developing countries. Neither of these will be easy to accomplish effectively, yet they are receiving minimal attention by policy makers.